Shelf-Stable Food Safety

Ever since man was a hunter-gatherer, he has sought ways to preserve food safely. People living in cold climates learned to freeze food for future use, and after electricity was invented, freezers and refrigerators kept food safe. But except for drying, packing in sugar syrup, or salting, keeping perishable food safe without refrigeration is a truly modern invention.

- What does "shelf stable" mean?
- How are foods made shelf stable?
- What is the history of canning?
- How does canning make food shelf stable?
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- Will commercially canned foods last forever?
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What does "shelf stable" mean?

Foods that can be safely stored at room temperature, or "on the shelf," are called "shelf stable." These non-perishable products include jerky, country hams, canned and bottled foods, rice, pasta, flour, sugar, spices, oils, and foods processed in aseptic or retort packages and other products that do not require refrigeration until after opening. Not all canned goods are shelf stable. Some canned food, such as some canned ham and seafood, are not safe at room temperature. These will be labeled "Keep Refrigerated."

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How are foods made shelf stable?
In order to be shelf stable, perishable food must be treated by heat and/or dried to destroy foodborne microorganisms that can cause illness or spoil food. Food can be packaged in sterile, airtight containers. All foods eventually spoil if not preserved.

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CANNED FOODS

What is the history of canning?
Napoleon is considered "the father" of canning. He offered 12,000 French francs to anyone who could find a way to prevent military food supplies from spoiling. Napoleon himself presented the prize in 1795 to Chef Nicholas Appert, who invented the process of packing meat and poultry in glass bottles, corking them, and submerging them in boiling water. Without realizing it, he sterilized them, stopping bacterial spoilage and growth.

This military secret soon reached England where, in 1810, Peter Durance patented the use of metal containers for canning. Englishman William Underwood migrated to Boston and established a canning plant in 1821. This was the beginning of canning in the United States. Underwood (even today, a brand of "deviled ham") is America's oldest canning company.

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How does canning make food shelf stable?
Canning is a way to store food for long periods of time. It is a method of preserving where food is placed in airtight, vacuum-sealed containers and heat processed at 250 °F (121 °C). This destroys microorganisms and inactivates enzymes. As the food cools, a vacuum seal is formed that prevents any new bacteria from getting in. Since the food in the container is commercially sterile, it does not spoil. Once the container is opened, however, bacteria can enter and begin growing in the food. Any unused portions must then be refrigerated in clean containers.

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Do cans contain lead?
The canned food industry in the United States stopped using lead-soldered cans in 1991. In 1995, the Food and Drug Administration issued a final rule prohibiting the use of lead solder in all food cans, including imported products. Metal cans, which are made of sheet steel — sometimes with a coating of tin — are now welded closed at the seams. The inside of the can may also have an enamel or vinyl protective coating.

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Will commercially canned foods last forever?
Commercial canning is done under tightly controlled conditions — careful sanitation and the necessary time and temperature under pressure, but there are still limits to how long it will preserve food. There are several factors that limit the shelf life of canned foods. First, cans can rust over time. Shipping accidents, where cans fall and dent or are crushed, also cause container problems.

Then there's can corrosion. In all foods, but especially in high-acid foods like canned tomatoes, natural chemicals in the food continually react with the container. Over several years, this can cause taste and texture changes, and eventually lower the nutritional value of the food.

High temperatures (over 100 °F) are harmful to canned goods too. The risk of spoilage jumps sharply as storage temperatures rise. In fact, canned goods designed for use in the tropics are specially manufactured.

Store canned foods and other shelf stable products in a cool, dry place. Never put them above or beside the stove, under the sink, in a damp garage or basement, or any place exposed to high or low temperature extremes. Temperatures below 85 °F are best. Check your pantry every few weeks and use canned goods you have had on hand for awhile. Don't purchase bulging, rusted, leaking, or deeply dented cans.

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After opening canned foods, is it safe to refrigerate the unused food in the can?
Yes. Unused portions of canned food may be refrigerated in the can, but to preserve optimum quality and flavor, place the unused portion in a glass or plastic storage container.

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Are all canned hams shelf stable?

Some canned hams are shelf stable and can be stored in the pantry up to 2 to 5 years at room temperature. These hams are generally not over 3 pounds in size. They have been processed to kill all spoilage bacteria and pathogenic organisms such as *Clostridium botulinum*, *Salmonella*, and *Trichinella spiralis*. The product is free of microorganisms capable of growing at ordinary room temperatures. However, unusually high temperature storage — above 122 °F (50 °C) — may result in harmless thermophylic bacteria multiplying and swelling or souring the product. If this happens, it should not be eaten.

Canned hams purchased refrigerated and bearing the "Keep Refrigerated" designation on the label are not safe to store at room temperature. This type of ham has been processed at a time/temperature sufficient to kill *Trichinella spiralis*. However, the normal cooking process for this product will not destroy the spores of *Clostridium botulinum* and *Clostridium perfringens* should they be present on the raw hams before canning. These two bacterial pathogens can grow if the perishable canned hams are not kept refrigerated. Consequently, the consumption of these canned hams may result in foodborne illnesses. "Keep Refrigerated" canned hams are also not free of spoilage bacteria that may eventually grow. Such hams may be stored in the refrigerator for up to 6 to 9 months.

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Is it safe to use rusted canned foods?
Discard heavily rusted cans. Cans that are heavily rusted can have tiny holes in them, allowing bacteria to enter. Surface rust that you can remove by rubbing with your finger or a paper towel is not serious. You can keep these canned foods. If you open the cans and there is any rust inside, do not eat the food. Rust (oxidized iron) is not safe to eat.

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Is it safe to use food from dented cans?
If a can containing food has a small dent, but is otherwise in good shape, the food should be safe to eat. Discard deeply dented cans. A deep dent is one that you can lay your finger into. Deep dents often have sharp points. A sharp dent on either the top or side seam can damage the seam and allow bacteria to enter the can. Discard any can with a deep dent on any seam.

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Is it safe to use cans that freeze accidentally?
Cans of food that freeze accidentally, such as those left in a car or basement in sub-zero temperatures, can present health problems. Frozen cans could swell because the food inside expanded when frozen. However, cans can be swollen because of contamination with *Clostridium botulinum* or spoilage-causing organisms. Do not use any swollen cans; discard them.

Also, discard frozen cans that are not swollen but have been allowed to thaw at 40 °F or higher. Cans that have thawed and refrozen are not safe.

A frozen can that has not thawed can be safely defrosted in the refrigerator and used. If the canned food is still frozen, let the intact can thaw in the refrigerator before opening. If the product doesn't look and/or smell normal, throw it out. Do not taste it!

If the product does look and/or smell normal, thoroughly cook the contents right away by boiling for 10 to 20 minutes. At altitudes below 1,000 feet, boil foods for 10 minutes. Add an additional minute of boiling time for each additional 1,000 feet elevation (for example, at 3,000 feet, boil for 12 minutes). Spinach and corn should be boiled for 20 minutes at all altitudes. This is due to the high density of these vegetables. Products can then be refrigerated or frozen for later use.

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If a can hisses when opened, is the food safe to eat?
Some cans make a hissing sound when opened because they are vacuum-packed and the noise is a result of air pressure. This is perfectly normal. However, if a can hisses loudly or the contents spurt forcefully out of the can when opened, it may be an indication that the food is unsafe. Do not taste or use such food. Place the can and its contents in a heavy garbage bag. Close and place the bag in a regular trash container or bury it in a nearby landfill.

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Do crystals in canned goods mean the food is not safe?
Canned seafood occasionally contains small fragments of a glass-like substance. According to the U.S. Food and Drug Administration (FDA), these crystals pose no danger to consumers. Known chemically as magnesium ammonium phosphate, commonly called "struvite," the crystals can form from certain natural constituents of the fish or shellfish after they are commercially canned.

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What is the danger of botulism in canned goods?
While extremely rare, a toxin or poison produced by the bacteria *Clostridium botulinum* (*C. botulinum*) is a very serious danger in canned goods. Botulism is a deadly food poisoning. The botulism bacteria — rod shaped under the microscope — grow best in anaerobic (absence of oxygen) conditions. Since the canning process forces air out of food, the *C. botulinum* bacteria may find incorrectly or minimally processed canned foods a good place to grow and produce the toxin. Low-acid vegetables such as green beans, corn, beets, and peas, which may have picked up *C. botulinum* spores from the soil, are at risk.

The botulism spores are heat-resistant, can survive in foods that are incorrectly or minimally processed, and are difficult to destroy. While high cooking temperatures will kill the normal *C. botulinum* organism, it takes even higher temperatures to kill the spore. That's why the canning of low-acid foods is done with a pressure canner. If the spores are not killed in the canning process, they can become normal cells again and produce the deadly toxin.

If you eat *C. botulinum*-contaminated food, symptoms will develop in 12 to 48 hours. The poison attacks the nervous system, causing double vision, droopy eyelids, trouble swallowing, and difficulty breathing. Without treatment, a patient can die of suffocation — the nerves no longer stimulate breathing. There is an antitoxin, which has reduced the number of deaths from botulism, but patients may still suffer nerve damage, and recovery is often slow.

To avoid botulism, carefully examine any canned food that looks suspicious. The risk is greater if containers have been canned at home without following safe canning procedures. Never use food from containers showing possible botulism warnings — leaking, bulging, or badly dented cans; cracked jars or jars with loose or bulging lids; canned food with a foul odor; milky liquids surrounding the vegetables that should be clear; or any container that spurts liquid when you open it. Don't even taste the food!

Throw canned goods that are suspect away carefully. You don't want animals, children, or anyone else who might rummage through the trash to get ill. Double bag the cans in plastic bags that are tightly closed. Then place them in a trash receptacle (non-recyclable trash) outside of the home.

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What are precautions for home-canned foods?
The botulism risk is greater for home-canned foods that have not been processed using safe canning guidelines. Boil all home-canned foods before serving. First, bring the food to a rapid boil. This brings out any telltale botulism odors. Some botulism bacteria produce gas you can smell; some don't. If the product smells right, lower the heat and continue boiling the food.

At altitudes below 1,000 feet, boil foods for 10 minutes. Add an additional minute of boiling time for each additional 1,000 feet of elevation. For example, at 3,000 feet, boil for 12 minutes.

Spinach and corn should be boiled for 20 minutes at any altitude. This is due to the high density of these vegetables. If a spoiled odor appears or the food is foaming or looks odd, throw it out without tasting it.

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Is the dating of shelf-stable foods required by federal law?
Except for infant formula and some baby food, product dating — having a "use-by," "sell-by," or "best-if-used-by" date — is not required by Federal regulations. Dating is for quality, not safety. However, if a calendar date is used, it must express both the month and day of the month (and the year, in the case of shelf-stable and frozen products). If a calendar date is shown, immediately adjacent to the date must be a phrase explaining the meaning of that date, such as "sell by" or "use before." While there is no uniform or universally accepted system used for food dating in the United States, dating of some foods is required by more than 20 states. A shelf-stable product can be safely used after the "sell-by" date. Products displaying a "use-by" date, although still safe, may not be of acceptable quality after the "use-by" date.

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What do the codes on cans mean?
Cans must exhibit a packing code to enable tracking of the product in interstate commerce. This enables manufacturers to rotate their stock as well as locate their products in the event of a recall. These codes, which appear as a series of letters and/or numbers, might refer to the date or time of manufacture. They aren't meant for the consumer to interpret as "use-by" dates. There is no book or Web site that tells how to translate the codes into dates; however, you can contact the manufacturer for further information. Cans may also display "open" or calendar dates. Usually these are "best-if-used-by" dates for peak quality.

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DRIED FOODS

What are dried foods?

Drying is the world's oldest and most common method of food preservation. Drying technology is both simple and readily available to most of the world's culture. Examples of dried foods are jerky, powdered milk, dried beans and peas, potatoes in a box, dried fruits and vegetables, pasta, and rice. Canning technology is just over 200 years old, and freezing became practical only during this century as electricity became increasingly available.

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What are the types of food drying?
Two types of natural drying occur in open air - solar (sun) drying and "adibatic" (shade) drying.

Adibatic drying occurs without heat.

Solar drying can be as simple as spreading a layer of fruit or vegetables in the sun, and it can also take place in a special container that catches and captures the sun's heat. These types of drying are used mainly for high-acid fruits and vegetables, such as apricots, tomatoes, and grapes (to make raisins). (Perishable, low-acid food such as meat and poultry may not be dried by these methods. See below.)

Drying from an artificial heat source is done by placing food in either a warm oven or a food dehydrator. Follow the appliance's directions carefully to ensure the food is dried safety.

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Why is temperature important when drying meat and poultry jerky?
There have been illnesses from *Salmonella* and *E. coli* O157:H7 from homemade jerky that raise questions about the safety of traditional drying methods for making beef and venison jerky.

To make jerky safely at home, the USDA Meat and Poultry Hotline recommends that consumers cook all meat to 160 °F and all poultry to 165 °F before they begin the dehydrating process. This cooking step ensures that any bacteria present will be destroyed. Most dehydrator instructions do not include this step, and a dehydrator may not reach high enough temperatures to heat meat and poultry to these safe temperatures.

After heating meat to 160 °F and poultry to 165 °F, maintain a constant dehydrator temperature of 130 to 140 °F during the drying process. This is important because the process must be fast enough to dry food before it becomes unsafe; and it must remove enough water so that microorganisms are unable to multiply.

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Why is it a food safety concern to dry meat without cooking it first?
The danger in dehydrating meat and poultry without cooking it to a safe temperature first is that the dehydrator will not heat meat to 160 °F or poultry to 165 °F — temperatures at which bacteria are destroyed — before the jerky dries. Bacteria that are not destroyed by cooking can survive dehydrating and cause foodborne illness.

In a dehydrator or low-temperature oven, most of the heat is absorbed by evaporating moisture. Thus, the temperature of the meat does not begin to rise until most of the moisture has evaporated. Therefore, when the dried meat temperature finally begins to rise, the bacteria have become more heat resistant and are more likely to survive. If these surviving bacteria are pathogenic (types that cause foodborne diseases), anyone who consumes the jerky can get a foodborne illness.

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Is jerky safe when stored at room temperature?
Yes. Commercially produced jerky is monitored in federally inspected plants by inspectors from the U.S. Department of Agriculture's Food Safety and Inspection Service. Products made into jerky may be cured or uncured, dried, smoked or unsmoked, and air or oven dried.

The process of making jerky at home can vary, so USDA recommends a shorter shelf life for homemade jerky than for jerky made under Federal inspection.

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How is salt used to make food shelf stable?
Salt binds or removes water so that it does not enable the growth of microorganisms. It is a food additive that has been used for thousands of years. Until canning was invented, salt was a critical food preservation item. In Colonial America, food preservation required 40 pounds of salt per person per year. Even though we don't need that much salt today, salt is still used to preserve or cure such foods as country hams, bacon, frankfurters, and corned beef.

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Are dry-cured hams shelf stable?
Dry-cured hams are shelf stable. These uncooked hams are safe when stored at room temperature because they contain so little water that bacteria can't multiply in them.

In dry curing — the process used to make country hams and prosciutto, fresh meat is rubbed with a dry-cure mixture of salt and other ingredients. Dry curing produces a salty product. Since dry curing draws out moisture, it reduces ham weight by at least 18% (usually 20 to 25%). This results in a more concentrated ham flavor. Dry-cured hams may be aged from a few weeks to more than a year. Six months is the traditional process, but may be shortened according to the aging temperature. Country hams may not be injected with curing solutions or placed in curing solutions, but they may be smoked. In 1992, FSIS approved a Trichina-treatment method that permits substituting up to half of the sodium chloride with potassium chloride to lower sodium levels.

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Are any sausages shelf stable?
Some dry sausages are shelf stable. Dry sausages include: Soppersata (a name of a salami); Salami; air-dried Pepperoni; Cerevelat; Lola, Lolita, and Lyons sausage (mildly seasoned pork with garlic); and Genoa salami (an Italian sausage usually made from pork, but might contain a small amount of beef and be moistened with wine or grape juice and seasoned with garlic). Dry sausages require more production time than other types of sausage and result in a concentrated form of meat. If the product is shelf stable and ready-to-eat, the product is not required to have a safe handling statement, cooking directions, or a "Keep Refrigerated" statement. For more information about sausages, see the document "Sausages and Food Safety" at www.fsis.usda.gov.

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Are any egg products shelf stable?
Pasteurized, dried egg products can be shelf stable, with or without added ingredients. Most are distributed in bulk quantities and are used by food manufacturers (noodle makers, bakers, etc.) or by institutional food service (hotels, hospitals, nursing homes, etc.).

USDA Dried Egg Mix — a dried blend of whole eggs, nonfat dry milk, soybean oil, and a small amount of salt — is distributed to schools and to needy families. This is a government commodity not usually available commercially. To reconstitute, blend 1/4 cup of the mix with 1/4 cup water to make one "egg." The reconstituted mix requires cooking. Pasteurized, dried egg whites are also available in stores that sell cake baking and decorating supplies. They do not require cooking.

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Does freeze-drying make food shelf stable?
Yes, freeze-dried foods are shelf stable. Freeze-drying is a commercial process that can be used to preserve such food as dried soup mixes, instant coffee, fruits, and vegetables. To freeze dry, frozen food is placed in a special vacuum cabinet. There, ice changes from a solid state directly to a vapor state without first becoming a liquid. This process, whereby water escapes from the food, is called "sublimation." To use freeze-dried foods, they must be rehydrated with water. They retain their original flavor, texture, and nutrients, but must be packaged in moisture-proof, hermetically sealed containers.

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FLEXIBLE PACKAGING

What is a retort pouch?
A retort pouch is commonly defined as a flexible pouch for low-acid foods that are thermally processed in a pressure vessel, often called a "retort." The pouch is made of layered polyester, aluminum foil, and polypropylene. Commercial sterilization occurs at temperatures greater than 212 °F, typically 240 to 250 °F. The retort packaging is shelf stable at room temperature.

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What is the history of retort pouches?
The history of retort pouches goes back to the 1960s when the military used them to replace C-Rations. They are lightweight and take up less space than canned goods. The development of the retort process had to overcome such problems as heat penetration, temperature distribution (some areas of the product cooking faster than others, resulting in hot or cold spots within the pouches), and residual air inside the package. Retort pouches are now available in clear or foil materials and are in several shapes. Special retort pouch features include hanger holes, pour spouts, handles, and tear notches.

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What are the advantages of the retort pouch?
The retort pouch has several advantages. It weighs less than a metal can. It is flexible, meaning that it can handle a lot of abuse when taken away from home or on military maneuvers. Because it is flat, it takes up little space, making it easier to carry in a backpack or pocket. The flat shape also gives the pouch an advantage during processing. In the plant, the pouch is filled with food, sealed, and then retorted at temperatures of 240 to 250 °F to commercially sterilize the contents. Because a pouch is flat, it takes much less time than a metal can does to heat the contents to the point of commercial sterilization. That can result in a better tasting product.

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What is an MRE?
MRE stands for "Meal, Ready-to-Eat." MRE's were originally designed for the U.S. government and have been used since the 1970's in the U.S. space program, U.S. military, and USDA's Forest Service. The MRE package is officially known as a tri-laminate retort pouch. It contains normal food that is ready to heat and consume, such as chili or beef stew.

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Is an MRE shelf stable?
Yes. MRE's are shelf stable because they have been commercially sterilized by heat in a sealed container to destroy bacteria that can make it unsafe or spoil the food. Like food in metal cans, MRE's can be kept for a long time, but not indefinitely. The shelf life is highly related to the storage temperature. For example, if stored at 120 °F (a temperature that could be encountered on desert battlefields), the MRE should be used within a month. Stored at 60 °F, an MRE can last 7 years or more.

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What foods are packaged in retort packages?
Nearly any type of food that comes in cans may be processed in retort packaging. Examples of food packaged in retort packages are chili, ham, chicken breasts, and tuna fish. These foods are available on grocery store shelves.

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What is aseptic packaging?
Aseptic packaging is the process by which microorganisms are prevented from entering a package during and after packaging. During aseptic processing, a sterilized package is filled with a commercially sterile food product and sealed within the confines of a hygienic environment.

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Are aseptic packages safe?
Yes. There are no health concerns associated with aseptic packaging. The inside layer of an aseptic package, which touches the product, is polyethylene (plastic). There is no leaching of aluminum or aluminum components through the polyethylene layer. The polyethylene used in the aseptic package, low-density polyethylene (LDPE), is an FDA-approved food-contact surface material. It is the only material in the package that comes in contact with the food product. In addition, industry tests have shown that no polyethylene leaches into the food product.

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What is the history of aseptic packaging?
Aseptic packaging is a beverage system first developed in Europe in cooperation with the World Health Organization to provide beverages such as milk and water to people involved in disasters. It was introduced to the United States in the early 1980's.

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What's the difference between retort and aseptic packaging?
In retort packaging, food is filled into a pouch or metal can, sealed, and then heated to extremely high temperatures, rendering the product commercially sterile. In aseptic packaging, the food or beverage is sterilized by quick exposure to ultra-high heat, rapidly cooled to an ambient temperature, and filled into sterilized containers that are then sealed in a commercially sterile environment. However, the assembled aseptic package is not further processed like retort products.

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What type of package is used for aseptic processing?
An aseptic package, sometimes called a "drink box," is a laminate of three materials: high-quality paperboard, polyethylene, and

aluminum. Paper (70%) provides stiffness, strength, and the efficient brick shape to the package. Polyethylene (24%) on the innermost layer forms the seals that make the package liquid-tight. A protective coating on the exterior keeps the package dry. Aluminum (6%) is the silver material on the inside of the aseptic package. This ultra-thin layer of foil forms a barrier against light and oxygen, eliminating the need for refrigeration and preventing spoilage without using preservatives.

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What foods are packaged in aseptic packages?

Aseptically packaged products include milk, juices, tomatoes, soups, broths, tofu, soy beverages, wines, liquid eggs, whipping cream, and teas.

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Can I microwave aseptic packages?

No. Because aseptic cartons contain a micro-thin layer of aluminum foil, the package cannot be used in a microwave. Check with the manufacturer of the product for specific information.

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Is *Sous Vide* packaging shelf stable?

No, it requires refrigeration. *Sous Vide* is a French phrase meaning "under vacuum." Most *Sous Vide* food is used in foodservice establishments such as restaurants, but some is becoming available to consumers. With this method, fresh, raw ingredients or partially cooked ingredients are vacuum-sealed in a plastic pouch. The pouch is heat processed, quickly chilled, and transported under refrigeration. Sous vide products must be kept refrigerated, but can be stored for 3 to 4 weeks. To serve, you simply heat the bag in boiling water.

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SHELF-STABLE FOOD STORAGE CHART

FOOD	STORAGE ON SHELF	STORAGE AFTER OPENING
Canned ham (shelf-stable)	2 to 5 years	3 to 4 days in the refrigerator
Low-acid canned goods. Examples: canned meat and poultry, stews, soups (except tomato), spaghetti (noodle and pasta) products, potatoes, corn, carrots, spinach, beans, beets, peas, and pumpkin.	2 to 5 years	3 to 4 days in the refrigerator
High-acid canned goods. Examples: juices (tomato, orange, lemon, lime, and grapefruit); tomatoes; grapefruit, pineapple, apples and apple products, mixed fruit, peaches, pears, plums, all berries, pickles, sauerkraut, and foods treated with vinegar-based sauces or dressings like German potato salad and sauerbraten.	12 to 18 months	5 to 7 days in the refrigerator
Home canned foods	12 months. Before using, boil 10 minutes for high-acid foods; 20 minutes for low-acid foods.	3 to 4 days in the refrigerator
Jerky, commercially packaged	12 months	N/A
Jerky, home-dried	1 to 2 months	N/A
Hard/dry sausage	6 weeks in pantry	3 weeks refrigerated, or until it no longer smells or tastes good.
USDA Dried Egg Mix	Store below 50 °F, preferably refrigerated, for 12 to 15 months.	Refrigerate after opening. Use within 7 to 10 days. Use reconstituted egg mix immediately or refrigerate and use within 1 hour.
Dried egg whites	Unopened dried egg products and egg white solids can be stored at room temperature as long as they are kept cool and dry. After opening, store in the refrigerator.	Refrigeration is not required unless reconstituted.
MRE's (Meal, Ready to Eat)	120 °F, 1 month 100 °F, 1 1/2 years 90 °F, 2 1/2 years 80 °F, 4 years 70 °F, 4 1/2 years	Refrigeration will increase the shelf-stable storage times.

	60 °F, 7 years	
Tuna and other seafood in retort pouches	18 months	3 to 4 days in the refrigerator
Meat or poultry products in retort pouches	Use manufacturer's recommendation on the package.	3 to 4 days in the refrigerator
Rice and dried pasta	2 years	After cooking, 3 to 4 days in the refrigerator

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Ever since man was a hunter-gatherer, he has sought ways to preserve food safely. People living in cold climates learned to freeze food for future use, and after electricity was invented, freezers and refrigerators kept food safe. But except for drying, packing in sugar syrup, or salting, keeping perishable food safe without refrigeration is a truly modern invention.

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- Is *Sous Vide* packaging shelf stable?
- Shelf-Stable Food Storage Chart

What does "shelf stable" mean?
Foods that can be safely stored at room temperature, or "on the shelf," are called "shelf stable." These non-perishable products include jerky, country hams, canned and bottled foods, rice, pasta, flour, sugar, spices, oils, and foods processed in aseptic or retort packages and other products that do not require refrigeration until after opening. Not all canned goods are shelf stable. Some canned food, such as some canned ham and seafood, are not safe at room temperature. These will be labeled "Keep Refrigerated."

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How are foods made shelf stable?
In order to be shelf stable, perishable food must be treated by heat and/or dried to destroy foodborne microorganisms that can cause illness or spoil food. Food can be packaged in sterile, airtight containers. All foods eventually spoil if not preserved.

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CANNED FOODS

What is the history of canning?
Napoleon is considered "the father" of canning. He offered 12,000 French francs to anyone who could find a way to prevent military food supplies from spoiling. Napoleon himself presented the prize in 1795 to Chef Nicholas Appert, who invented the process of packing meat and poultry in glass bottles, corking them, and submerging them in boiling water. Without realizing it, he sterilized them, stopping bacterial spoilage and growth.

This military secret soon reached England where, in 1810, Peter Durance patented the use of metal containers for canning. Englishman William Underwood migrated to Boston and established a canning plant in 1821. This was the beginning of canning in the United States. Underwood (even today, a brand of "deviled ham") is America's oldest canning company.

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How does canning make food shelf stable?
Canning is a way to store food for long periods of time. It is a method of preserving where food is placed in airtight, vacuum-sealed containers and heat processed at 250 °F (121 °C). This destroys microorganisms and inactivates enzymes. As the food cools, a vacuum seal is formed that prevents any new bacteria from getting in. Since the food in the container is commercially sterile, it does not spoil. Once the container is opened, however, bacteria can enter and begin growing in the food. Any unused portions must then be refrigerated in clean containers.

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Do cans contain lead?
The canned food industry in the United States stopped using lead-soldered cans in 1991. In 1995, the Food and Drug Administration issued a final rule prohibiting the use of lead solder in all food cans, including imported products. Metal cans, which are made of sheet steel — sometimes with a coating of tin — are now welded closed at the seams. The inside of the can may also have an enamel or vinyl protective coating.

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Will commercially canned foods last forever?
Commercial canning is done under tightly controlled conditions — careful sanitation and the necessary time and temperature under pressure, but there are still limits to how long it will preserve food. There are several factors that limit the shelf life of canned foods. First, cans can rust over time. Shipping accidents, where cans fall and dent or are crushed, also cause container problems.

Then there's can corrosion. In all foods, but especially in high-acid foods like canned tomatoes, natural chemicals in the food continually react with the container. Over several years, this can cause taste and texture changes, and eventually lower the nutritional value of the food.

High temperatures (over 100 °F) are harmful to canned goods too. The risk of spoilage jumps sharply as storage temperatures rise. In fact, canned goods designed for use in the tropics are specially manufactured.

Store canned foods and other shelf stable products in a cool, dry place. Never put them above or beside the stove, under the sink, in a damp garage or basement, or any place exposed to high or low temperature extremes. Temperatures below 85 °F are best. Check your pantry every few weeks and use canned goods you have had on hand for awhile. Don't purchase bulging, rusted, leaking, or deeply dented cans.

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After opening canned foods, is it safe to refrigerate the unused food in the can?
Yes. Unused portions of canned food may be refrigerated in the can, but to preserve optimum quality and flavor, place the unused portion in a glass or plastic storage container.

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Are all canned hams shelf stable?
Some canned hams are shelf stable and can be stored in the pantry up to 2 to 5 years at room temperature. These hams are generally not over 3 pounds in size. They have been processed to kill all spoilage bacteria and pathogenic organisms such as *Clostridium botulinum*, *Salmonella*, and *Trichinella spiralis*. The product is free of microorganisms capable of growing at ordinary room temperatures. However, unusually high temperature storage — above 122 °F (50 °C) — may result in harmless thermophylic bacteria multiplying and swelling or souring the product. If this happens, it should not be eaten.

Canned hams purchased refrigerated and bearing the "Keep Refrigerated" designation on the label are not safe to store at room temperature. This type of ham has been processed at a time/temperature sufficient to kill *Trichinella spiralis*. However, the normal cooking process for this product will not destroy the spores of *Clostridium botulinum* and *Clostridium perfringens* should they be present on the raw hams before canning. These two bacterial pathogens can grow if the perishable canned hams are not kept refrigerated. Consequently, the consumption of these canned hams may result in foodborne illnesses. "Keep Refrigerated" canned hams are also not free of spoilage bacteria that may eventually grow. Such hams may be stored in the refrigerator for up to 6 to 9 months.

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Is it safe to use rusted canned foods?
Discard heavily rusted cans. Cans that are heavily rusted can have tiny holes in them, allowing bacteria to enter. Surface rust that you can remove by rubbing with your finger or a paper towel is not serious. You can keep these canned foods. If you open the cans and there is any rust inside, do not eat the food. Rust (oxidized iron) is not safe to eat.

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Is it safe to use food from dented cans?
If a can containing food has a small dent, but is otherwise in good shape, the food should be safe to eat. Discard deeply dented cans. A deep dent is one that you can lay your finger into. Deep dents often have sharp points. A sharp dent on either the top or side seam can damage the seam and allow bacteria to enter the can. Discard any can with a deep dent on any seam.

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Is it safe to use cans that freeze accidentally?
Cans of food that freeze accidentally, such as those left in a car or basement in sub-zero temperatures, can present health problems. Frozen cans could swell because the food inside expanded when frozen. However, cans can be swollen because of contamination

Clostridium botulinum

with or spoilage-causing organisms. Do not use any swollen cans; discard them.

Also, discard frozen cans that are not swollen but have been allowed to thaw at 40 °F or higher. Cans that have thawed and refrozen are not safe.

A frozen can that has not thawed can be safely defrosted in the refrigerator and used. If the canned food is still frozen, let the intact can thaw in the refrigerator before opening. If the product doesn't look and/or smell normal, throw it out. Do not taste it!

If the product does look and/or smell normal, thoroughly cook the contents right away by boiling for 10 to 20 minutes. At altitudes below 1,000 feet, boil foods for 10 minutes. Add an additional minute of boiling time for each additional 1,000 feet elevation (for example, at 3,000 feet, boil for 12 minutes). Spinach and corn should be boiled for 20 minutes at all altitudes. This is due to the high density of these vegetables. Products can then be refrigerated or frozen for later use.

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If a can hisses when opened, is the food safe to eat?
Some cans make a hissing sound when opened because they are vacuum-packed and the noise is a result of air pressure. This is perfectly normal. However, if a can hisses loudly or the contents spurt forcefully out of the can when opened, it may be an indication that the food is unsafe. Do not taste or use such food. Place the can and its contents in a heavy garbage bag. Close and place the bag in a regular trash container or bury it in a nearby landfill.

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Do crystals in canned goods mean the food is not safe?
Canned seafood occasionally contains small fragments of a glass-like substance. According to the U.S. Food and Drug Administration (FDA), these crystals pose no danger to consumers. Known chemically as magnesium ammonium phosphate, commonly called "struvite," the crystals can form from certain natural constituents of the fish or shellfish after they are commercially canned.

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What is the danger of botulism in canned goods?
While extremely rare, a toxin or poison produced by the bacteria *Clostridium botulinum* (*C. botulinum*) is a very serious danger in canned goods. Botulism is a deadly food poisoning. The botulism bacteria — rod shaped under the microscope — grow best in anaerobic (absence of oxygen) conditions. Since the canning process forces air out of food, the *C. botulinum* bacteria may find incorrectly or minimally processed canned foods a good place to grow and produce the toxin. Low-acid vegetables such as green beans, corn, beets, and peas, which may have picked up *C. botulinum* spores from the soil, are at risk.

The botulism spores are heat-resistant, can survive in foods that are incorrectly or minimally processed, and are difficult to destroy. While high cooking temperatures will kill the normal *C. botulinum* organism, it takes even higher temperatures to kill the spore. That's why the canning of low-acid foods is done with a pressure canner. If the spores are not killed in the canning process, they can become normal cells again and produce the deadly toxin.

If you eat *C. botulinum*-contaminated food, symptoms will develop in 12 to 48 hours. The poison attacks the nervous system, causing double vision, droopy eyelids, trouble swallowing, and difficulty breathing. Without treatment, a patient can die of suffocation — the nerves no longer stimulate breathing. There is an antitoxin, which has reduced the number of deaths from botulism, but patients may still suffer nerve damage, and recovery is often slow.

To avoid botulism, carefully examine any canned food that looks suspicious. The risk is greater if containers have been canned at home without following safe canning procedures. Never use food from containers showing possible botulism warnings — leaking, bulging, or badly dented cans; cracked jars or jars with loose or

bulging lids; canned food with a foul odor; milky liquids surrounding the vegetables that should be clear; or any container that spurts liquid when you open it. Don't even taste the food!

Throw canned goods that are suspect away carefully. You don't want animals, children, or anyone else who might rummage through the trash to get ill. Double bag the cans in plastic bags that are tightly closed. Then place them in a trash receptacle (non-recyclable trash) outside of the home.

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What are precautions for home-canned foods?
The botulism risk is greater for home-canned foods that have not been processed using safe canning guidelines. Boil all home-canned foods before serving. First, bring the food to a rapid boil. This brings out any telltale botulism odors. Some botulism bacteria produce gas you can smell; some don't. If the product smells right, lower the heat and continue boiling the food.

At altitudes below 1,000 feet, boil foods for 10 minutes. Add an additional minute of boiling time for each additional 1,000 feet of elevation. For example, at 3,000 feet, boil for 12 minutes.

Spinach and corn should be boiled for 20 minutes at any altitude. This is due to the high density of these vegetables. If a spoiled odor appears or the food is foaming or looks odd, throw it out without tasting it.

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Is the dating of shelf-stable foods required by federal law?
Except for infant formula and some baby food, product dating — having a "use-by," "sell-by," or "best-if-used-by" date — is not required by Federal regulations. Dating is for quality, not safety. However, if a calendar date is used, it must express both the month and day of the month (and the year, in the case of shelf-stable and frozen products). If a calendar date is shown, immediately adjacent to the date must be a phrase explaining the meaning of that date, such as "sell by" or "use before." While there is no uniform or universally accepted system used for food dating in the United States, dating of some foods is required by more than 20 states. A shelf-stable product can be safely used after the "sell-by" date. Products displaying a "use-by" date, although still safe, may not be of acceptable quality after the "use-by" date.

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What do the codes on cans mean?
Cans must exhibit a packing code to enable tracking of the product in interstate commerce. This enables manufacturers to rotate their stock as well as locate their products in the event of a recall. These codes, which appear as a series of letters and/or numbers, might refer to the date or time of manufacture. They aren't meant for the consumer to interpret as "use-by" dates. There is no book or Web site that tells how to translate the codes into dates; however, you can contact the manufacturer for further information. Cans may also display "open" or calendar dates. Usually these are "best-if-used-by" dates for peak quality.

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DRIED FOODS

What are dried foods?
Drying is the world's oldest and most common method of food preservation. Drying technology is both simple and readily available to most of the world's culture. Examples of dried foods are jerky, powdered milk, dried beans and peas, potatoes in a box, dried fruits and vegetables, pasta, and rice. Canning technology is just over 200 years old, and freezing became practical only during this century as electricity became increasingly available.

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What are the types of food drying?

Two types of natural drying occur in open air - solar (sun) drying and "adibatic" (shade) drying.

Adibatic drying occurs without heat.

Solar drying can be as simple as spreading a layer of fruit or vegetables in the sun, and it can also take place in a special container that catches and captures the sun's heat. These types of drying are used mainly for high-acid fruits and vegetables, such as apricots, tomatoes, and grapes (to make raisins). (Perishable, low-acid food such as meat and poultry may not be dried by these methods. See below.)

Drying from an artificial heat source is done by placing food in either a warm oven or a food dehydrator. Follow the appliance's directions carefully to ensure the food is dried safety.

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Why is temperature important when drying meat and poultry jerky?
There have been illnesses from *Salmonella* and *E. coli* O157:H7 from homemade jerky that raise questions about the safety of traditional drying methods for making beef and venison jerky.

To make jerky safely at home, the USDA Meat and Poultry Hotline recommends that consumers cook all meat to 160 °F and all poultry to 165 °F before they begin the dehydrating process. This cooking step ensures that any bacteria present will be destroyed. Most dehydrator instructions do not include this step, and a dehydrator may not reach high enough temperatures to heat meat and poultry to these safe temperatures.

After heating meat to 160 °F and poultry to 165 °F, maintain a constant dehydrator temperature of 130 to 140 °F during the drying process. This is important because the process must be fast enough to dry food before it becomes unsafe; and it must remove enough water so that microorganisms are unable to multiply.

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Why is it a food safety concern to dry meat without cooking it first?
The danger in dehydrating meat and poultry without cooking it to a safe temperature first is that the dehydrator will not heat meat to 160 °F or poultry to 165 °F — temperatures at which bacteria are destroyed — before the jerky dries. Bacteria that are not destroyed by cooking can survive dehydrating and cause foodborne illness.

In a dehydrator or low-temperature oven, most of the heat is absorbed by evaporating moisture. Thus, the temperature of the meat does not begin to rise until most of the moisture has evaporated. Therefore, when the dried meat temperature finally begins to rise, the bacteria have become more heat resistant and are more likely to survive. If these surviving bacteria are pathogenic (types that cause foodborne diseases), anyone who consumes the jerky can get a foodborne illness.

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Is jerky safe when stored at room temperature?
Yes. Commercially produced jerky is monitored in federally inspected plants by inspectors from the U.S. Department of Agriculture's Food Safety and Inspection Service. Products made into jerky may be cured or uncured, dried, smoked or unsmoked, and air or oven dried.

The process of making jerky at home can vary, so USDA recommends a shorter shelf life for homemade jerky than for jerky made under Federal inspection.

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How is salt used to make food shelf stable?
Salt binds or removes water so that it does not enable the growth of microorganisms. It is a food additive that has been used for thousands of years. Until canning was invented, salt was a critical

food preservation item. In Colonial America, food preservation required 40 pounds of salt per person per year. Even though we don't need that much salt today, salt is still used to preserve or cure such foods as country hams, bacon, frankfurters, and corned beef.

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Are dry-cured hams shelf stable?
Dry-cured hams are shelf stable. These uncooked hams are safe when stored at room temperature because they contain so little water that bacteria can't multiply in them.

In dry curing — the process used to make country hams and prosciutto, fresh meat is rubbed with a dry-cure mixture of salt and other ingredients. Dry curing produces a salty product. Since dry curing draws out moisture, it reduces ham weight by at least 18% (usually 20 to 25%). This results in a more concentrated ham flavor. Dry-cured hams may be aged from a few weeks to more than a year. Six months is the traditional process, but may be shortened according to the aging temperature. Country hams may not be injected with curing solutions or placed in curing solutions, but they may be smoked. In 1992, FSIS approved a Trichina-treatment method that permits substituting up to half of the sodium chloride with potassium chloride to lower sodium levels.

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Are any sausages shelf stable?
Some dry sausages are shelf stable. Dry sausages include: Soppersata (a name of a salami); Salami; air-dried Pepperoni; Cerevelat; Lola, Lolita, and Lyons sausage (mildly seasoned pork with garlic); and Genoa salami (an Italian sausage usually made from pork, but might contain a small amount of beef and be moistened with wine or grape juice and seasoned with garlic). Dry sausages require more production time than other types of sausage and result in a concentrated form of meat. If the product is shelf stable and ready-to-eat, the product is not required to have a safe handling statement, cooking directions, or a "Keep Refrigerated" statement. For more information about sausages, see the document "Sausages and Food Safety" at www.fsis.usda.gov.

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Are any egg products shelf stable?
Pasteurized, dried egg products can be shelf stable, with or without added ingredients. Most are distributed in bulk quantities and are used by food manufacturers (noodle makers, bakers, etc.) or by institutional food service (hotels, hospitals, nursing homes, etc.).

USDA Dried Egg Mix — a dried blend of whole eggs, nonfat dry milk, soybean oil, and a small amount of salt — is distributed to schools and to needy families. This is a government commodity not usually available commercially. To reconstitute, blend 1/4 cup of the mix with 1/4 cup water to make one "egg." The reconstituted mix requires cooking. Pasteurized, dried egg whites are also available in stores that sell cake baking and decorating supplies. They do not require cooking.

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Does freeze-drying make food shelf stable?
Yes, freeze-dried foods are shelf stable. Freeze-drying is a commercial process that can be used to preserve such food as dried soup mixes, instant coffee, fruits, and vegetables. To freeze dry, frozen food is placed in a special vacuum cabinet. There, ice changes from a solid state directly to a vapor state without first becoming a liquid. This process, whereby water escapes from the food, is called "sublimation." To use freeze-dried foods, they must be rehydrated with water. They retain their original flavor, texture, and nutrients, but must be packaged in moisture-proof, hermetically sealed containers.

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FLEXIBLE PACKAGING

What is a retort pouch?
A retort pouch is commonly defined as a flexible pouch for low-acid foods that are thermally processed in a pressure vessel, often called a "retort." The pouch is made of layered polyester, aluminum foil, and polypropylene. Commercial sterilization occurs at temperatures greater than 212 °F, typically 240 to 250 °F. The retort packaging is shelf stable at room temperature.

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What is the history of retort pouches?
The history of retort pouches goes back to the 1960s when the military used them to replace C-Rations. They are lightweight and take up less space than canned goods. The development of the retort process had to overcome such problems as heat penetration, temperature distribution (some areas of the product cooking faster than others, resulting in hot or cold spots within the pouches), and residual air inside the package. Retort pouches are now available in clear or foil materials and are in several shapes. Special retort pouch features include hanger holes, pour spouts, handles, and tear notches.

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What are the advantages of the retort pouch?
The retort pouch has several advantages. It weighs less than a metal can. It is flexible, meaning that it can handle a lot of abuse when taken away from home or on military maneuvers. Because it is flat, it takes up little space, making it easier to carry in a backpack or pocket. The flat shape also gives the pouch an advantage during processing. In the plant, the pouch is filled with food, sealed, and then retorted at temperatures of 240 to 250 °F to commercially sterilize the contents. Because a pouch is flat, it takes much less time than a metal can does to heat the contents to the point of commercial sterilization. That can result in a better tasting product.

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What is an MRE?
MRE stands for "Meal, Ready-to-Eat." MRE's were originally designed for the U.S. government and have been used since the 1970's in the U.S. space program, U.S. military, and USDA's Forest Service. The MRE package is officially known as a tri-laminate retort pouch. It contains normal food that is ready to heat and consume, such as chili or beef stew.

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Is an MRE shelf stable?
Yes. MRE's are shelf stable because they have been commercially sterilized by heat in a sealed container to destroy bacteria that can make it unsafe or spoil the food. Like food in metal cans, MRE's can be kept for a long time, but not indefinitely. The shelf life is highly related to the storage temperature. For example, if stored at 120 °F (a temperature that could be encountered on desert battlefields), the MRE should be used within a month. Stored at 60 °F, an MRE can last 7 years or more.

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What foods are packaged in retort packages?
Nearly any type of food that comes in cans may be processed in retort packaging. Examples of food packaged in retort packages are chili, ham, chicken breasts, and tuna fish. These foods are available on grocery store shelves.

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What is aseptic packaging?
Aseptic packaging is the process by which microorganisms are prevented from entering a package during and after packaging. During aseptic processing, a sterilized package is filled with a commercially sterile food product and sealed within the confines of a hygienic environment.

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Are aseptic packages safe?
Yes. There are no health concerns associated with aseptic packaging. The inside layer of an aseptic package, which touches the product, is polyethylene (plastic). There is no leaching of aluminum or aluminum components through the polyethylene layer. The polyethylene used in the aseptic package, low-density polyethylene (LDPE), is an FDA-approved food-contact surface material. It is the only material in the package that comes in contact with the food product. In addition, industry tests have shown that no polyethylene leaches into the food product.

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What is the history of aseptic packaging?
Aseptic packaging is a beverage system first developed in Europe in cooperation with the World Health Organization to provide beverages such as milk and water to people involved in disasters. It was introduced to the United States in the early 1980's.

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What's the difference between retort and aseptic packaging?
In retort packaging, food is filled into a pouch or metal can, sealed, and then heated to extremely high temperatures, rendering the product commercially sterile. In aseptic packaging, the food or beverage is sterilized by quick exposure to ultra-high heat, rapidly cooled to an ambient temperature, and filled into sterilized containers that are then sealed in a commercially sterile environment. However, the assembled aseptic package is not further processed like retort products.

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What type of package is used for aseptic processing?
An aseptic package, sometimes called a "drink box," is a laminate of three materials: high-quality paperboard, polyethylene, and aluminum. Paper (70%) provides stiffness, strength, and the efficient brick shape to the package. Polyethylene (24%) on the innermost layer forms the seals that make the package liquid-tight. A protective coating on the exterior keeps the package dry. Aluminum (6%) is the silver material on the inside of the aseptic package. This ultra-thin layer of foil forms a barrier against light and oxygen, eliminating the need for refrigeration and preventing spoilage without using preservatives.

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What foods are packaged in aseptic packages?
Aseptically packaged products include milk, juices, tomatoes, soups, broths, tofu, soy beverages, wines, liquid eggs, whipping cream, and teas.

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Can I microwave aseptic packages?
No. Because aseptic cartons contain a micro-thin layer of aluminum foil, the package cannot be used in a microwave. Check with the manufacturer of the product for specific information.

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Is *Sous Vide* packaging shelf stable?
No, it requires refrigeration. *Sous Vide* is a French phrase meaning "under vacuum." Most *Sous Vide* food is used in foodservice establishments such as restaurants, but some is becoming available to consumers. With this method, fresh, raw ingredients or partially cooked ingredients are vacuum-sealed in a plastic pouch. The pouch is heat processed, quickly chilled, and transported under refrigeration. Sous vide products must be kept refrigerated, but can be stored for 3 to 4 weeks. To serve, you simply heat the bag in boiling water.

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SHELF-STABLE FOOD STORAGE CHART

FOOD	STORAGE ON SHELF	STORAGE AFTER OPENING
Canned ham (shelf-stable)	2 to 5 years	3 to 4 days in the refrigerator
Low-acid canned goods. Examples: canned meat and poultry, stews, soups (except tomato), spaghetti (noodle and pasta) products, potatoes, corn, carrots, spinach, beans, beets, peas, and pumpkin.	2 to 5 years	3 to 4 days in the refrigerator
High-acid canned goods. Examples: juices (tomato, orange, lemon, lime, and grapefruit); tomatoes; grapefruit, pineapple, apples and apple products, mixed fruit, peaches, pears, plums, all berries, pickles, sauerkraut, and foods treated with vinegar-based sauces or dressings like German potato salad and sauerbraten.	12 to 18 months	5 to 7 days in the refrigerator
Home canned foods	12 months. Before using, boil 10 minutes for high-acid foods; 20 minutes for low-acid foods.	3 to 4 days in the refrigerator
Jerky, commercially packaged	12 months	N/A
Jerky, home-dried	1 to 2 months	N/A
Hard/dry sausage	6 weeks in pantry	3 weeks refrigerated, or until it no longer smells or tastes good.
USDA Dried Egg Mix	Store below 50 °F, preferably refrigerated, for 12 to 15 months.	Refrigerate after opening. Use within 7 to 10 days. Use reconstituted egg mix immediately or refrigerate and use within 1 hour.
Dried egg whites	Unopened dried egg products and egg white solids can be stored at room temperature as long as they are kept cool and dry. After opening, store in the refrigerator.	Refrigeration is not required unless reconstituted.
MRE's (Meal, Ready to Eat)	120 °F, 1 month 100 °F, 1 1/2 years 90 °F, 2 1/2 years 80 °F, 4 years 70 °F, 4 1/2 years 60 °F, 7 years	Refrigeration will increase the shelf-stable storage times.
Tuna and other seafood in retort pouches	18 months	3 to 4 days in the refrigerator
Meat or poultry products in retort pouches	Use manufacturer's recommendation	3 to 4 days in the

	on the package.	refrigerator
Rice and dried pasta	2 years	After cooking, 3 to 4 days in the refrigerator

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